

Blending Calculation:

Niagara Falls Samples

EPA has taken samples for assessment, enforcement, and removal purposes throughout the past year. Due to site shutdown, the samples must now be disposed. EPA would like to dispose of all samples located on the NFB site. These samples range from a variety of Areas located on site, and consist of both high and low concentrations. All samples have been analyzed by onsite laboratory, and some of those samples have been returned from the offsite laboratories.

Data

The number of soil samples that will be disposed is 476 with varying concentrations and weighs. These samples come from areas of throughout the Niagara Falls Boulevard site where assessment and removal was performed. The soil sample concentrations for these sample batches ranges from background concentrations to hundreds of pCi/g. Initially, all samples were analyzed with the onsite laboratory with the onsite high purity germanium detector (HPGe), then the samples were sent to the offsite laboratory. In most cases, the offsite laboratory kept and disposed of the samples. However, for enforcement purposes, questionable data results, and future references, some of the samples were returned to EPA upon EPA's request. The sample batches that are being disposed may have the following results: onsite HPGe data only, or both onsite and offsite data results. When results are analyzed by both onsite and offsite results, the highest of the two were used for disposal calculations. In addition, to be conservative, all results were assumed to be in secular equilibrium. The highest between the parent and daughter was used for all calculations. Each sample was independently analyzed. No averaging of data occurred.

The attached Microsoft Excel document, "NFB_Disposal Data_EPA_3August2017," shows the results for each sample with results of the onsite HPGe and some with the offsite HPGe. The highest between the two results are listed in the column "Disposal Value" in units of pCi/g. The Disposal Values were used to calculate the overall concentrations for Th-232, Th-228, Th-230, Th-234, U-238, U-234, U-235, and Ra-226. To determine the overall concentrations, the following example of Th-232 was used:

$$C_{Th-232} = \frac{(C_1 \times P_1) + (C_2 \times P_2) + (C_3 \times P_3) + \dots + (C_n \times P_n)}{Pounds_1 + Pounds_2 + Pounds_3 + \dots + Pounds_n}$$

Where C_1 =concentration of sample #1 in pCi/g of Th-232

C_2 =concentration of sample #2 in pCi/g of Th-232

C_3 =concentration of sample #3 in pCi/g of Th-232

C_n =concentration of last sample in the data set in pCi/g of Th-232

C_{Th-232} =concentration of all of the samples for Th-232 pCi/g

Pounds₁=weight in pounds of sample #1

Pounds₂=weight in pounds of sample #2

Pounds₃=weight in pounds of sample #3

Pounds_n=weight in pounds of last sample

Pounds_{Total of Th-232}=weight in pounds of all of the samples

To simplify the process, the highest concentration for each radionuclide within each sample was determined. Again, the highest value assume secular equilibrium, and the highest value for all of the radionuclides in the parent decay chain were given the highest value. Once the highest value was determined, the highest value for each radionuclide was multiplied by the weight of the sample, then listed in the excel document as “(pCi/g)(pounds)” for each sample. All of the (pCi/g)(pounds) were summed for every samples for each radionuclide. The total summed (pCi/g)(pounds) for the overall disposal truck shipment was divided by the total weight of the entire data series (i.e. 1287 pounds) to determine the concentration of the radionuclide within the disposal shipment. The concentrations were converted to mg/kg concentrations and compared to the waste acceptance criteria (WAC) as seen in Table 1 below.

Radionuclide	Concentration (pCi/g)	Concentration (mg/kg)	WAC	Greater/Below WAC?
Th-232	57.28	524.2606	500 mg/kg	Greater
Th-228	57.28	7.01E-08	500 mg/kg	Below
Th-230	27.64	1.2E-09	500 mg/kg	Below
Th-234	27.64	0.001346	500 mg/kg	Below
U-238	27.64	83.10165	500 mg/kg	Below
U-234	27.64	0.004448	500 mg/kg	Below
U-235	0.20	0.091649	500 mg/kg	Below
Ra-226	28.24	Not Needed	50 pCi/g	Below

Table 1. Overall concentrations and comparison to WAC

Down Blending concentrations

From previous disposals, a large pile of clean dirt has been set aside for downblending in order to meet the WAC of the disposal facility. The highest concentration of the clean pile has been used from previous samples. Table 2 lists the highest concentration for the clean sample pile.

	pCi/g	mg/kg
Radium-226 (Ra-226)	5.17	5.16E-06
Thorium-228 (Th-228)	1.11	1.35E-09
Thorium-230 (Th-230)	3.34	1.62E-04
Thorium-232 Th-232)	1.11	10.1
Thorium-234 Th-234)	3.34	1.44E-10
Uranium-233/234 (U-233/234)	3.34	5.35E-04
Uranium-235/236 (U-235/236)	7.01	3.24
Uranium-238 (U-238)	3.34	9.99

Table 2. List of Clean Concentrations

To determine how much clean concentration is needed to downblend the disposal shipment to meet the WAC, the following calculation was performed:

[illegible]

Where $C_{500\text{mg/kg}}$ = the concentration for the WAC for the total radionuclides (i.e. 500mg/mg)
 C_{clean} = concentration of the clean blending material
 C_{material} = the concentration of the material being shipped to disposal facility
Pounds_{Total} = the total pounds of the disposal shipment
Pounds_{clean} = the total pounds of the clean material needed to downblend
Pounds_{material} = the total weight in pounds of the radionuclide with the highest concentration

Using Th-232 as the driver for downblending, the above equation can be written as:

$$\left(\frac{500^{?? ??}}{????}\right)(1287^{??+? ? ? ?} \cdot 2^{??} + 252426^{\frac{??? ?}{??}} \times 1287^{??}) + (10.1\% / ?^? \times 2^{??} \cdot 2^{??} \cdot 2^{??})$$

From the above calculation, the amount of clean soil, with Th-232 concentration of 1.11pCi/g, was calculated to be 63.7 pounds. For simplicity, logistics, and conservativeness, EPA filled one full super sack, roughly 3000 pounds, of material to be used for downblending. With using a full super sack of clean material, the final concentration of the truckload is calculated as below.

[illegible]

Where C_{total} = the total concentration of the truckload after downblending
 $\text{Pounds}_{\text{total}}$ = the total pounds of the truckload after downblending, includes the material weight to be disposed plus the clean material used for downblending
 C_{material} = the concentration of the material needed to be disposed
 $\text{Pounds}_{\text{material}}$ = the weight of the material needing to be disposed
 C_{clean} = the concentration of the clean material used for downblending
 $\text{Pounds}_{\text{clean}}$ = the weight of the clean material used for downblending

With the information listed in the excel spreadsheet, the above equation can be re-written to determine the total concentration of the material in the disposal shipment.

$$(2.2 \times (1287 + 3000)) = (524.26 / 2 \times 1287) + (1017 / 2 \times 3000)$$

The overall Th-232 concentration for the shipment was 164.456. This is well below the WAC for the disposal facility.